



# Crisis Management and Simulation Training: Analysis of Crisis Managers' Behavior Using Activity Logs

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**Abstract.** Crises are key moments in companies' lifetimes, especially for high risks industrial systems. The Expert'Crise project trains managers to manage crises through theoretical training and accident simulation exercises. The trainees' performance during the exercise is a key factor in their learning process, which is completed by a debriefing. However, a detailed analysis is needed to understand what exactly happens between the managers inside the crisis room during the exercises. We have, therefore, developed a methodology, based on observations, in order to give feedback to managers and to suggest recommendations for improving emergency planning.

The purpose of this paper is to present this methodological approach, based on the construction of trainee activity logs. During the exercise, observational data collection is carried out through observation grids and camera recordings. After the exercise, the observers' notes and camera recordings are collated and incorporated into a global database, compiling key information about the trainees' actions and communications. Thereafter, a set of issues encountered by the crisis unit is identified from the database. Several descriptors of the level of completion of these issues are then defined.

Once the database has been sorted, according to these issues and their levels of completion, the log of the trainees' activity is complete. Each issue is now ready to be analyzed through some strategic crisis topics, such as communication, leadership inside the crisis unit, accordance with crisis roles set in the emergency instructions, difficulties and deviations encountered for each issue, and achieving the learning targets.

**Keywords:** Simulation exercise · Activity analysis · Crisis management

## 1 Introduction

### 1.1 Background: Crisis Management and Simulation Training

Crises are key moments in companies' lifetimes, especially for high risks industrial systems, and cover a large spectrum of realities (e.g. sanitary problems, natural disasters, extended power and water outage, etc.) [1]. In connection with the underlying project presented below, crises are considered, in this paper, as unexpected and disruptive situations following a severe accident, which are possibly not listed in the companies' emergency planning documents. The consequences of such events may

threaten human lives both on and off the site, the environment, critical infrastructure, and sometimes the very survival of the company. These situations, therefore, require an urgent response provided by several stakeholders, including the internal crisis unit, which is often composed of the company's managers and decision makers who have to use a specific skillset. Indeed, these exceptional situations involve a particular and paradoxical reaction: while managers are not used to dealing with complex and rare accidental events, they still have to react immediately in an efficient and inventive way [2]. Thus, managers need to be trained to display specific behaviors and skills related to crisis management, such as decision-making and exchanging information [3].

From this perspective, simulation training – which is frequently used and studied in medical training – can be of interest, regarding learning targets. During a simulation, trainees can practice within a risk-free environment, and can, therefore, make errors without impacting anyone's health or safety [4]. Moreover, simulations enable trainees to be exposed to rare and complex conditions, which is very important for crisis management training [4]. Furthermore, simulation-based learning is experiential and reflexive [5]. Most of the time, this “learning by doing” process concludes with a debriefing providing feedback, also allowing trainees to adopt a reflexive overview of their own in-simulation activity [6].

## **1.2 Context: The Expert'Crise Project**

Since 2015, the Expert'Crise project – funded by the European Social Fund – has aimed to develop crisis management training programs incorporating two components, depending on the target audience: emergency services, and high risks industrial systems (e.g. Seveso companies). This paper focuses on the latter. Managers and decision-makers are trained to manage crises through theoretical training and on-site accident simulation exercises (mainly simulated in chemical companies) [7].

Each exercise has three steps: briefing, simulation session, and two debriefings (the first at the end of the session, the second after in-depth analysis). The simulation scenario is based on a detailed analysis of the company's emergency management system. Hence, the scenario is highly bound by legal and internal procedures. The exercise is built in close collaboration with the company, but not with the trainees themselves, which leads to a credible scenario for the trainees.

This preparation process results in a partial exercise (i.e. not full-scale), which is close to a real world scenario, functionally speaking [8]. Some crisis management training makes use of virtual reality [9], but the Expert'Crise project employs learning role playing games [10] where the trainees play their own roles in the crisis management system, and the trainers play predefined fictional roles, acting as members of the emergency services, media and official authorities.

## 2 Methods

### 2.1 Framework

If we adhere to the professional didactic framework inspired by the ergonomic trends in French-speaking countries, the trainees' activity during the simulation sessions consists of two main parts: constructive (linked to skills) and productive (linked to performance) activity [11]. The trainees' activity during the exercise is, therefore, a key factor in their learning process [12], as is the debriefing which follows the exercise [13]. While the scientific literature on simulation training gives debriefing a key place in the learning process, concerning the reflexive approach in particular [14], a significant part of learning still relies on the activity performed by trainees during the simulation itself [15]. The experiential approach of simulation-based learning puts trainees' and trainers' activity at heart of research and training programs. This highlights the need for tools to analyze activity, especially when it is carried out in such a complex and uncertain context, such as a crisis, which places both the trainees and trainers into trouble.

Consequently, in addition to the first debriefing, a detailed analysis is needed to understand precisely what happened during the Expert'Crise simulation, specifically inside the crisis room, between the crisis resolution agents (i.e. decisions, communication and relational processes). We, therefore, developed a methodology based on observations in order to give feedback to managers and to suggest recommendations for improving emergency planning, both on material and organizational levels.

Up to this day, the Expert'Crise project has organized simulation exercises at eight companies<sup>1</sup>. Six exercises (Table 1) were analyzed through the methodology presented below.

**Table 1.** Expert'Crise exercises to date

Exercise	Companies	Exercise and environment	Type of exercise [16]
1 <sup>a</sup>	A, B, C	Coordinated exercise between three companies on multi-operator site	Full-scale (A), functional (B), NA (C)
2	D	Single-site exercise on multi-operator site	Functional
3	E	Single-site exercise, isolated site	Functional
4	F	Single-site exercise, isolated site	Functional
5	C <sup>b</sup>	Single-site exercise on multi-operator site	Functional
6	G	Single-site exercise, isolated site	Functional
7	H	Single-site exercise, isolated site	Functional

<sup>a</sup>Exercise that was carried out before the completion of the methodology presented in this paper.

<sup>b</sup>Second exercise on the C-site.

<sup>1</sup> One of these eight companies (company C) was involved in two different exercises, but the first exercise (carried out with companies A and B) was not analyzed with the presented methodology.

## 2.2 Data Processing

The observational data collection was done through camera recordings, and observation grids (Table 2). During the exercise, the cameras and observers were located in strategic positions on the site, for example in the crisis room, control room, and disaster site.

**Table 2.** Excerpt of the observation grid (single line)

Time	Actions	Communication			
		Agents		Message content	
		Sender	Receiver	Sender's words	Receiver's words
		<input type="checkbox"/> Person 1	<input type="checkbox"/> Person 1		
		<input type="checkbox"/> Person 2	<input type="checkbox"/> Person 2		
		<input type="checkbox"/> ...	<input type="checkbox"/> ...		
		Vector			
		<input type="checkbox"/> In person	<input type="checkbox"/> Radio		
		<input type="checkbox"/> Mobile	<input type="checkbox"/> Landline		
		<input type="checkbox"/> Computer	<input type="checkbox"/> Other:		

After the exercise, all of the observers' grids were collated, in order to avoid data redundancy if several observers took notes of the same event, and then integrated into a single database (Table 3). The database was then completed with information from the camera recordings if grey areas remained. At this stage, the data were not completely processed as they still had to be sorted. In order to do so, a set of issues encountered by the crisis unit was identified from the database and the learning targets (i.e. situations-tasks) determined during the exercise preparation (e.g. warning level management, crisis unit mobilization, accident identification and management, media and authorities contact) were considered. In some cases, a single observation line could match several issues (e.g. several topics raised in one conversation), hence the observation lines needed to be split until they matched only one issue. Conversely, it was also possible that some observation lines matched no issue (e.g. missed call, conversation not related to the exercise), and were therefore considered extraneous to crisis management lead by trainees.

Several descriptors for the level of completion of these issues were then defined. The issue is raised (level 1, red flagged) when encountered for the first time by the crisis unit, or when mentioned without being resolved or questioned. The issue is being resolved (level 2, yellow flagged) if mentioned at least for the second time and is the subject of information, actions, questions or discussions by the crisis unit. At last, the issue is resolved (level 3, green flagged) when crisis unit members implement actions to resolve the issue, or receive confirmation that the problem is over.

Finally, this database includes key information about trainees' actions and communications: each action and communication (i.e. each processed observation line) relevant to crisis management is linked to an issue and a level of completion.

**Table 3.** Excerpt of the fifth exercise database (simplified)

Time	Actions	Message content		Issue	Level of completion
		Sender	Receiver		
10h04		Guard: (1) Accident in column 4, there's ammoniac smoke... (3) There's one person injured	First aid: (2) I will put on my equipment and alert my colleagues. Any other information? (4) Trigger the alarm	Alert	1
10h05	Alarm goes off			Alert	2
(...)					
10h17		Crisis unit chief: (1) Did you call for first aid? (3) Is someone injured? (5) Do we know who?	Guard: (2) All I know is that there's ammoniac smoke and we need a fire truck operator (4) Yes (6) No, they didn't tell me... He isn't moving anymore...	Crisis unit intervention	2
10h18		Evacuation manager: (1) John and Peter aren't here, so I'll do the evacuation count	Guard: (2) OK, let me give you the list	Evacuation count	1

### 2.3 Data Analysis

Once the database is sorted according to these issues and their levels of completion, the log of the trainees' activity is complete. This way, a table summarizing issue emergence and resolution can be achieved by means of a timeline taking the levels of completion (in the lines), and the issues concerned (in the columns) into consideration (Table 4). Each issue is now ready to be analyzed through strategic crisis management topics. These topics include communication, leadership inside the crisis unit, accordance with crisis roles set in the emergency instructions, issue resolution, difficulties and deviations encountered during each issue resolution, and achieving the learning targets.

From a global perspective, analysis includes crisis phase identification (i.e. warning chain, crisis management, and recovery process), communication flows within the crisis location, the means of communication and related difficulties (e.g. defecting mobile network or landline, means of communication in insufficient number or variety).

The next step was to count the interventions performed by each crisis unit member, first overall, to identify the one who was leading the crisis management team, and then issue by issue, to check the accordance with crisis roles set by the emergency instructions. For instance, it is obvious that the evacuation manager is expected to be

involved in the evacuation and count processes, but it might not be the case in the simulation exercise, and the reason why then needs to be identified.

Other interesting elements in analyzing crisis management are the differences between the trainees' actions and the emergency procedures, which are sometimes necessary when responding to an unexpected situation (i.e. outside the emergency planning) [17]. Any differences may show that procedures are inappropriate, inefficient, contradictory, incomplete or simply not understood. Therefore, these procedures have to be adjusted, or the team members have to be trained. Besides any identified differences, it is necessary to pinpoint and explain difficulties encountered by the crisis unit during simulation, such as lost documents, undefined crisis roles or mission, and poorly prepared crisis management.

**Table 4.** Sixth exercise timeline

Time	Alert	Emergency services contact	Evacuation	Injured person care	Fire fighting	Pollution restricting	Message to media	Missing person care
09h30	1							
09h35	2	1	1					
09h40	2	2	2	1				
09h45	3			2	1			
09h50			3	2	2	1		
09h55		2		2	2	2		
10h00		2		2	2	2	1	
10h05		2			2			
10h10								1
10h15		2						

The analysis ends with a short crisis summary. This last point checks if the simulation exercise was a success concerning the learning targets (e.g. defining roles and missions, defining strategical priorities, cooperating, acquiring/collecting available information, coordinating used resources) and the situation-tasks (e.g. identifying the accidental situation, overcoming communication problems with field staff, coordinating with emergency services) prepared in advance of the simulation exercise [11].

### 3 Conclusion

In the end, the activity log is not as exhaustive as the initial database but it arranges raw data, classifies them into logical groups, and retains the crisis key crisis resolution elements in a simple and usable way. The observation grids are quite basic but give observers a wide degree of freedom to take notes, and they can be easily transferred from one exercise to another.

The purpose of this whole analysis process is to give concrete recommendations about crisis management resources and organization in order to help crisis units be better prepared to deal with the next crisis. For instance, while crisis management resources suggest changes focused on protective equipment, means of communication, and crisis room equipment, crisis organization adjustments are often related to the definition of crisis roles, training of operators and managers, information sharing, and crisis follow-up.

The major challenge leading to the methodology presented in this paper is to achieve cost effective trainee activity analysis. To do so, the Expert'Crise trainers chose to rely mainly on observational data from a third-person perspective without any complementary questionnaires or trainee interviews (besides the first debriefing, which is taken into account in the analysis process). Indeed, a literature review [18] legitimates the third-person perspective for analyzing activity by inferring "pragmatic judgments" from activity observation [19], which can also be expressed by trainees themselves during interviews.

Finally, the presented methodology is clearly not exhaustive and the analysis of trainee's actions in a crisis simulation exercise may include other factors, such as situation awareness, resource managing, planning or anticipation [4]. Therefore, self-confrontation interviews, for example, can complete this methodology to investigate these crisis management factors.

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